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0316004.1 - 8 JUL 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

ZEROSHIFT Ltd
The Coplan Building
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Patents ADP number *(if you know it)*

8669301001

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4. Title of the invention

Control Method for Discrete Ratio Transmissions

5. Name of your agent *(if you have one)*

N/A

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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Signature

Date 7th July 03

12. Name and daytime telephone number of person to contact in the United Kingdom Bill Martin 01908 617 469

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Control Method for Discrete Ratio Transmissions

This invention relates to a method for improving shift quality of transmission systems having discrete gear ratios and rapid gearshifts such as that described in application GB 0310482.5.

Where the transition between discrete gear ratios is virtually instantaneous there is little or no time for the inertia of the drive or driven device to dissipate before the next gear ratio is engaged. This causes inertia spikes.

In order to smooth out such shifts, a new approach to shift strategy must be devised.

It is one object of the present invention to provide a means for the control of rapid shifting transmission systems to reduce or eliminate inertia spikes when changing between discrete gear ratios.

This invention is for a method for controlling a transmission system having at least two gear ratios, and preferably, a means to provide slip of the power (such as a clutch) in order to provide shifts with minimum fluctuation in power through the drivetrain throughout the shift.

The method includes (but is not limited to) setting a slipping device to, or near to, the onset of slip prior to effecting a gear shift so that inertia or torque spikes during the shift process (due to the shift) between the power source, and the driven device, are unable to be fully transferred through the driveline.

Additionally or alternatively, drive (engine) power may be reduced on an up shift and increased on a downshift to reduce torque spikes during shifts. Both scenarios result in reduced period of clutch slip thus increasing clutch life.

Traction control may be used to control wheel-spin during shifts.

Various embodiments will now be described using the drivetrain of a motor vehicle as an example:

Any fluctuations in driveline torque to the driven wheels may reduce shift quality and provide the potential for breaking traction. Shift quality control is therefore best dictated by sensing torque changes in the driveline.

The control system is programmed to maintain constant driveline torque during gearshifts to pre set limits such as less than 2% change from that sensed immediately prior to the shift.

It is critical that the control system does not cause a driveline torque reversal at the instant the shift is made. This would inhibit the function of the two-way engagement system (with the exception of the kick-down sequence below).

An example for an up shift includes the following:

A change is instigated by the driver or a management system.

The management system then:

Detects the call for a change and;

Takes a reading of drive torque on the clutch output side of the driveline with a torque sensor or a strain gauge, and;

Activates the servo / actuator controlling the clutch to commence reduction of the pressure between the clutch plates until the clutch plates begin to slip relative to each other. Slip is detected by comparing RPM sensors (Hall effect) on the input and output side of the clutch, and;

Holds the clutch at that pressure, and;

Activates the actuators on the selectors to shift ratios, and;

Overrides driver throttle position to reduce engine power (reduce fuel supply) to assist the maintenance of the previously measured driveline torque level and:

Continuously attempts to reduce clutch slip without exceeding the maximum allowable variation in driveline torque; and

Continues the above step until the clutch ceases to slip; and

Activates the clutch actuator to restore the clutch to the in gear pressure condition, and;

Attempts to restore engine torque to the level before the shift without exceeding the drive-shaft torque level, and

Continues the above step until engine power is restored, and

Restores the engine control to driver / throttle input.

Where confirmation of a change in gear ratio is required, a Hall effect sensor or similar may be used to detect the position of an engagement means inside the gearbox.

The method for a decelerating down shift is identical to the above with the single exception that:

Upon engagement of the new gear, fuel supply to the engine is increased instead of reduced as above.

For a downshift under acceleration (kick-down) the method is as per the decelerating downshift above except that:

Immediately prior to and during the shift the control system causes a momentary reduction of engine torque to, or near to zero (fuel cut) to allow the shift to occur. Throttle is then returned to that required to maintain drive-shaft torque (driver override) or driver input (whichever is the greater).

Due to windup in the driveline, the shift should be made immediately upon the drive shaft torque sensor detecting the torque reduction to, or near to zero. At

that instant the shift can be made and the torque reinstated. It should take no more than 20 milliseconds for the torque to reduce, then a further 20 milliseconds for the shift, then a further 20 milliseconds to reinstate the torque.

A throttle blip may be added during the shift to increase engine speed prior to engaging the lower ratio. This may mean a hesitation at the neutral point during the shift, thus an increase beyond the 20 millisecond shift time.

For a kick down to be required the car is in the wrong gear and therefore unable to accelerate at the required rate until the shift is completed. This means that the momentary interruption in torque for the shift will be virtually undetectable.

Prior to the engagement of any gear the gear/ shaft relative rotational positions may be measured (Hall effect) to ensure that the engagement is within the open window of the locking system to reduce wear.

Unless the context indicates otherwise: one or more of any of the above steps may be performed simultaneously; and sequences and/or parts of sequences may combine.

Modifications and variations such as would be apparent to the skilled addressee are considered to fall within the scope of the present invention.